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MORPHOLOGICAL AND SYSTEMATIC NOTES ON SOUTH AMERICAN LAND SNAILS: ACHATINIDÆ.

BY HENRY A. PILSBRY AND EDWARD G. VANATTA.

Dr. H. von Ihering, director of the Museu Paulista, having entrusted to the senior author of this paper a considerable collection of alcoholic preparations of land snails amassed during his residence in Brazil, a beginning of their study is herein made.

It must be regretted by all that von Ihering, urged by the pressure of official duties, could not himself conduct the investigation of this important material; for his large experience with South American forms of life and his genius for dealing with problems of molluscan morphology, would have given an especial value to the work.

Alcoholic specimens of two genera of *Achatinidæ* are present. Neither of them has hitherto been investigated.

Genus **NEOBELISCUS** Pilsbry.

Nautilus, x, p. 46 (August, 1896).

Shell solid and strong, large, imperforate, turreted, slowly tapering, several earlier whorls rapidly tapering, forming a conic apex. Whorls about 10, similarly sculptured, convex. Aperture irregularly ovate, the outer lip unexpanded, acute, columella vertical, foldless, its edge narrowly revolute and adnate throughout.

Foot very short and broad, squarely truncated behind; with no appearance of grooves or specialized granulation above the margins; sole undivided.

Genitalia (Pl. XV, fig. 5) without accessory organs, the atrium short. ♂ system with a long, club-shaped penis with strongly folded internal walls, and terminal retractor muscle and vas deferens. Talon (fig. 5*a*, *t*.) large, consisting of a swollen distal portion on a narrow, devious duct of similar length. ♀ system with the vagina rather short, spermatheca oblong, borne on a duct of about double its own length, and remote from the heart. Free oviduct as long as the spermatheca duct. Uterus with thin walls, enormously distended when containing young, two of which occupy it at a time.

Albumen gland (figs. 5, 5*a*, *a. gl.*) very small, shorter than the talon and far smaller than the spermatheca. Median moiety of the hermaphrodite duct extravagantly convoluted and knotted.

Viviparous; the shell of the young at birth is nearly one-fourth the length, and exceeds one-third the diameter of adult shells, with half the number of whorls.

Retractor muscle system (Pl. XVI, fig. 9) somewhat resembling that of *Rumina;* right, left and tail retractors free except at the very insertion, where they are very shortly united. Tail retractor very long; right retractor splitting up distally into (1) numerous anterior and lateral pedal retractors, (2) the retractor of the eye, and (3) the retractor of the penis; left retractor giving rise (1) far anteriorly to the short pharyngeal retractor which is shortly bifurcate anteriorly, and (2) in front of this, splitting into ocular and pedal retractors.

Lung (Pl. XVI, fig. 14) long and narrow, the venation faint, mainly concentrated anteriorly and consisting chiefly of fine parallel veins transverse to the pulmonary vein, which is otherwise unbranched. Heart normal. Kidney more than double the length of the pericardium, quite narrow, its length contained about 3½ times in that of the lung. Ureter retrograde, continued along the gut, closed throughout.

The jaw (Pl. XV, fig. 4) is arcuate, densely striated, under strong magnification showing transverse striolation in its substance, crenulating the vertical striæ.

Radula composed of 44, 1, 44 teeth in slightly bow-shaped rows (Pl. XV, fig. 1). Centrals very narrow, less than one-fourth the width of the adjacent laterals, and bearing no cusps in adult animals. Laterals with the basal plate wide and square, tricuspid, the median cusp broadly conic, not as long as the basal plate, side cusps short and blunt. Marginal teeth with longer and blunt cutting points on the median, and more acute cutting points on the side cusps.

Salivary glands united above. Crop moderately swollen, stomach small, globose.

Type *N.* [*Helix*] *calcarea* Born. Distribution, Brazil and upper Amazon drainage.

Affinities of Neobeliscus.

Neobeliscus is a genus full of novel and interesting structures; and while future knowledge of those genera of Stenogyroid *Achatinidæ* of which the soft anatomy is yet unknown will doubtless reduce the number of characteristics peculiar to the genus, it will probably still remain somewhat isolated. The clumsy summit of the shell, very different from the small bulbous nucleus of *Stenogyra obeliscus*, *Rumina decollata* and other large forms, is one of the obvious conchological stigmata.

The dull silken lustre of the shell of the enormous uterine young, produced by dense fine lamellose striæ, and uncut by the spirals which appear on the post-natal growth, is not paralleled in *Stenogyra*, which is glossy at first. But it is in the reproductive organs that the most striking features are seen.

The penis is simple in structure, wanting the peculiar external sheath so characteristic of *Achatina;* but its retractor muscle arises not from the diaphragm as in almost all *Vasopulmonata*, but *from the right tentacular and pedal band.* It would not seem reasonable to question the homology of this penial retractor with the usual one, but how so radical a change of base could have been effected is problematic. We know of no other snail in which the tentacular retractor contributes a fascia to the genital system. The talon (shown partially straightened out in fig. 5*a*, *t.*) is large as in *Callionepion*, but of a different shape. The attached portion of the sperm duct is composed of a dense mass of radiating vermiform tubules or cæca, a detail not drawn in the figure. The uterus in virgin or functionally inactive individuals is shrunken, and lies in numerous deep, regular longitudinal plaits. When carrying young at almost full term it presents the appearance shown in fig. 5, the young lying with the head directed anteriorly, the ventral face toward the sperm duct. The head of the uterine young is retracted; and from the upper surface of the foot, about the position of the operculum in an operculate snail, there arises a flat membrane which spreads over the ventral face of the young shell (Pl. XV, fig. 6, *ap.*). From the hollow base of this placenta-like organ a duct penetrates forward and upward through the tissues of the foot; but from the poor preservation of the infant tissues in our material we could not ascertain what it communicates with. From what was observed it appears likely that the spreading membrane and its duct are analogous to the mammalian placenta and umbilical cord. This probability is enhanced by *the reduction of the albumen gland to a mere rudiment or vestige,* evidently of but slight functional importance, and probably throwing the function of supplying nutriment to the embryo upon the arteries of the uterus.

In the viviparous *Stylodonta* something of the same sort occurs,[1] though I do not know that the albumen gland is obsolete in that genus.

The jaw and teeth are quite what we would expect, though the absence of a cusp on the narrow central is a further specialization in line with the general degeneration of that tooth in *Achatinidæ.* In the radula of a uterine embryo, however, that cusp was found developed (Pl. XV, fig. 2), and all of the cusps, as would be expected of teeth which had never been used, are longer and more acute.

The myology offers some interesting characters. As in *Rumina* (figured for comparison in Pl. XV, fig. 10), the retractor of the pharynx (*ph. r.*) is short and branches from the left retractor band far forward. Unlike *Rumina,* it bifurcates. We regard the branch *br.* of the left retractor band as probably a mere anomaly. It is one of the lateral pedal retractors. All three retractor bands are free to the proximal root, where they are very shortly though firmly united. This is unlike *Rumina,* in which the right retractor and the tail retractor are united for a distance nearly as great as the free length of the latter. The anomalous insertion of the retractor of the penis has already been discussed.

The lung resembles that of *Rumina* (figured in Pl. XVI, fig. 15 for comparison) in the absence of large branches on the pulmonary vein, and the mainly transverse venation, which in *Neobeliscus,* however, is much finer and fainter.

History of the Generic Name.

In regard to the name herein used for the genus, some explanation may be advisable. In a former paper,[2] the senior author proposed the name *Neobeliscus* for the species *calcareus* Born and *cuneus*

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[1] See Viguer's paper, or the synopsis given in *Man. Conch.* (2), ix, p. 150.

[2] *Nautilus,* x, 46 (1896).

Pfr. Hitherto they have been grouped together with another series of large species, of which *Helix obeliscus* Moric. is a typical example, under the name *Obeliscus* Beck;[3] but Gray, in 1847, nominated as the type of that group the *Helix obtusata* of Gmelin, a species of Madagascar for which the name *Clavator* was subsequently proposed. *Obeliscus* has also been used by Humphrey[4] in 1797 as a generic name for the *Trochus dolabratus* of Linné, which was later called *Pyramidella* by Lamarck. Clearly, then, we cannot retain the name for these South American snails.

In 1854, Shuttleworth[5] proposed the genus *Stenogyra* to include as subgenera the prior groups *Rumina* Risso (1826), *Obeliscus* and *Subulina* Beck (1837), *Opeas* Albers (1850), and the new subgenus *Pseudobalea.*

These sections, as Shuttleworth terms them, are briefly defined, but no types are mentioned; after which the species of the island of Porto Rico are enumerated: *Stenogyra* (*Opeas*) *subula* Pfr., *Stenogyra* (*Opeas*) *octonoides* C. B. Ad., *Stenogyra* (*Opeas*) *margaritacea* Shuttl., *Stenogyra* (*Opeas*) *alabastrina* Shuttl., *Stenogyra* (*Opeas*) *gomphorium* Shuttl., *Stenogyra* (*Opeas*) *Goodalli* Mill., *Stenogyra* (*Pseudobalea*) *Dominicensis* Pfr., *Stenogyra* (*Obeliscus*) *Swiftiana* Pfr., *Stenogyra* (*Obeliscus*) *terebraster* Pfr., *Stenogyra* (*Subulina*) *octona* Ch., *Stenogyra* (*Subulina*) *acicularis* Shuttl.

No type species was selected, nor did Dr. von Martens name one in treating of the group in the second edition of Albers' *Die Heliceen.* It is obvious that *Stenogyra* cannot replace the older groups mentioned above, but can only be used for some constituent of the mass not already provided with a name. Such a one is found in the so-called *Obeliscus* of Shuttleworth's list; for, as explained above, *Obeliscus* cannot be used in this connection. We would therefore restrict *Stenogyra* to the *Obeliscus* of Shuttleworth's list, taking *S. terebraster* as the type. Other large Antillean species, such as *S. Salleana* of San Domingo and *S. gigas* of Cuba belong here, with probably the larger continental species grouping around *S. obeliscus.* None of the species are known anatomically, but the small apical whorls and more numerous volutions separate them from those now referred to *Neobeliscus.*

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[3] *Index Molluscorum,* p. 61 (1837).

[4] *Museum Calonnianum,* p. 24.

[5] *Diagn. Neuer Moll.,* No. 6, Bern. Mittheil., 1854, p. 137.

Compare *S. obeliscus* (Mor.) with *N. calcareus* (Born), or *S. gigas* (Poey) with *N. cuneus* (Pfr.).

Genus **CALLIONEPION** nov.

Shell turreted, slowly tapering, with diamond-granulate nepionic shell of about 2½ whorls, retained in the adult, the subsequent whorls differently sculptured. Type species with 9½ moderately convex whorls, apex very obtuse. Aperture ovate, with slightly expanded outer lip, the columellar lip with free expanded edge (as in *Bulimulus* or *Opeas*); columella with a small, rather sharp oblique median fold.

Genitalia (Pl. XV, fig. 8) without accessory organs; atrium short. ♂ system with the penis large, elongate, the vas deferens inserted at its apex, beyond which a hollow tube or sack (fig. 8, *x.*) of unknown nature extends, terminating in a short retractor muscle; talon (*t.*) large, composed of a thick curved basal portion and a slightly longer, narrow terminal part. ♀ system with the vagina short; spermatheca globular, lodged near the heart, its duct long and slender; free oviduct very short, the convoluted portion unusually long; albumen gland well developed. Hermaphrodite duct moderately convoluted.

Apparently oviparous, the young shell when hatched about one-tenth the length and less than one-third the diameter of the adult shell.

The right eye-retractor muscle passes between ♂ and ♀ branches of genital system; the penis retractor muscle is inserted upon the diaphragm.

The jaw is lost, and the radula obtained is frayed at the edges, so that the number of teeth in a transverse row cannot be stated, but it was probably not over fifty. The rachis consists of well-developed teeth, fully as wide as the laterals, with square basal plate and tricuspid reflection, the middle cusp large, though shorter than the basal plate; the side cusps small. In the lateral teeth an inner cusp is absent. Marginals similar, with oblique mesocone, acute small ectocone and short basal plate.

Type *Callionepion Iheringi* n. sp.

Affinities of Callionepion.

The peculiar disparity between the sculpture of the nepionic and post-nepionic whorls of the shell (when not obscured by erosion), the free, expanded edge of the columellar lip, and the sharp though small median fold on the columella, are characters sundering *Callionepion* from other South American Stenogyroid genera.

The vagina is much shorter than in *Rumina* (where it equals the length of the spermatheca duct), and the duct of the spermatheca is longer than in *Rumina, Achatina, Neobeliscus* or *Opeas,* being caught with the gut in the loop of the aorta, and consequently the spermatheca lies near the heart, as shown in the diagram annexed to fig. 8*a*.

In the wide teeth of the median row, this genus differs remarkably from all known American *Achatinidæ* of the " Stenogyra " form, departing from the type of dentition nearly universal in the family.

Callionepion Iheringi n. sp. Pl. XV, figs. 11, 12, 13.

Shell rimate, turreted, narrow, subregularly tapering; surface glossy, covered with a greenish cuticle, somewhat irregularly plicatulate, decussated by numerous minute spiral striæ or very short cuticular processes, which are lost by wear from the greater part of the shell, and then appear as lightly impressed lines. Whorls 9½, moderately convex, separated by impressed sutures, the apex very obtuse, with depressed tip, surface of the earlier 2¼ whorls cut into an evenly granose pattern by close, deep, obliquely descending grooves intersecting at right angles; last whorl rounded at base. Aperture irregularly ovate, slightly oblique, its length contained 3½ times in that of the shell; peristome thin, acute, the outer margin slightly expanded, columellar margin reflexed, dilated, impressed at its insertion, bearing a low, narrow submedian oblique fold. Internal pillar slender and nearly straight, with a low spiral fold within the last whorl.

Alt. 24, diam. 7, length of aperture 6.6 mm.

Alt. 23.5, diam. 7, length of aperture 7 mm.

Piquete, Prov. São Paulo, Brazil (Dr. H. von Ihering).

The peculiar apical sculpture separates this from all other South American Stenogyroid species known to me. When this sculpture is obscured by erosion, as occurs to a greater or less extent in many adult shells, the slightly expanded lip and median fold of the columella are still obvious recognition marks. The type is No. 71,258, coll. Acad. Nat. Sci. Phila.

Summary.—The two genera described above are not closely related to forms known anatomically from other regions, and therefore throw no light upon the vexed questions of the alliance of the South American fauna to that of tropical Africa or other regions. They can have no bearing on the hypothetical Antarctica. *Neobeliscus* is the most highly specialized member of the *Achatinidæ* known, and apparently forms no capsule of albumen, but nourishes the embryo directly, as in mammals. The teeth are ultra-achatinoid, and the muscle system aberrant. *Callionepion* is probably an individualized survivor of a primitive achatinoid, retaining the early form of teeth. There is no reason for believing that either genus reached South America from without.

DESCRIPTION OF PLATES.

PLATE XV.

Fig. 1. *Neobeliscus calcareus* (Born). Teeth of an adult individual. R., rachidian or median tooth; the side teeth are numbered.

Fig. 2. Teeth of a uterine young individual (fig. 7) of the same species.

Fig. 3. *Callionepion Iheringi* n. sp. Teeth. R., rachidian; L., 1; laterals 15, a marginal tooth.

Fig. 4. *Neobeliscus calcareus.* Jaw.

Fig. 5. *Neobeliscus calcareus.* Genitalia of an individual carrying two uterine young, the anterior one about at full term. × 1¼. No. 73,455, coll. Acad. Nat. Sci. Phila. *a. gl.*, albumen gland; *atr.*, atrium; *h. d.*, hermaphrodite, or ovisperm duct; *r. r.*, right retractor muscle; *p. r.*, penis retractor; *p.*, penis; *sp.*, spermatheca; *t*, talon; *ut.*, uterus.

Fig. 5*a*. Albumen gland (*a. gl.*), talon (*t.*) and beginning of the hermaphrodite duct (*h. d.*), of the same individual. × 4, the organs separated.

Fig. 6. Uterine young of the same, ventral aspect. *f.*, foot; *ap.*, placenta-like appendage. Somewhat less than natural size.

Fig. 7. Shell of the same. Somewhat less than natural size.

Fig. 8. *Callionepion Iheringi.* Genitalia × 3¼. Letters as for fig. 5; *x.*, hollow sack. No. 73,454, coll. Acad. Nat. Sci. Phila.

Fig. 8*a*. Diagram showing the relation of the cephalic branch of the aorta (*ao.*) to the gut (G^2, G^3) and spermatheca (*sp.*). ***H.***, heart.

PLATE XVI.

Fig. 9. *Neobeliscus calcareus.* Free retractor muscles, dorsal aspect. *br.*, branch of left retractor; *l. o. r.*, left ocular retractor; *l. r.*, left retractor; *p.*, penis; *ph.*, pharynx, or buccal mass; *ph. r.*, pharyngeal retractor; *p. r.*, retractor of the penis; *r. o. r.*, right ocular retractor; *r. r.*, right retractor; *r. t. r.*, right tentacular retractor; *t. r.*, tail retractor.

Fig. 10. *Rumina decollata* (L.). Free retractor muscles × 2, dorsal aspect. Lettering as in preceding figure. Specimen from Malta, No. 72,504, coll. Acad. Nat. Sci. Phila. The pharynx and pharyngeal retractor are removed from their normal median position, and placed to the left.

Fig. 11. *Callionepion Iheringi.* Shell, natural size. No. 71,258, coll. Acad. Nat. Sci. Phila.

Fig. 12. Apical whorls of same, much enlarged.

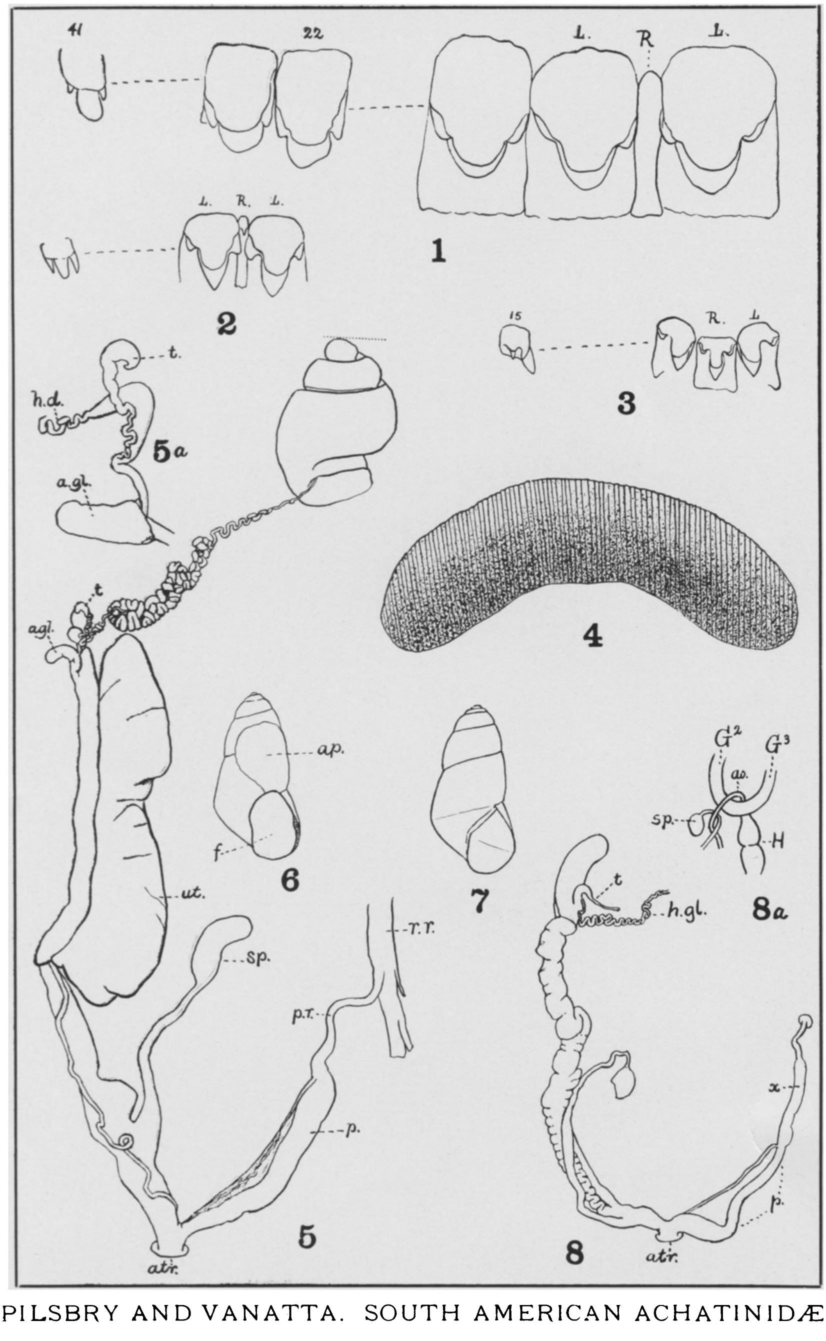
Fig. 13. Aperture of same, enlarged.

Fig. 14. *Neobeliscus calcareus.* Intestine and pallial region, slightly less than natural size. G^{1-4}, four folds of the gut; *g. u. r.*, secondary ureter; ***H.***, heart; *k.*, kidney; *p. v.*, pulmonary vein; *st.*, stomach; *ur.*, ureter.

Fig. 15. *Rumina decollata.* Intestine and pallial region × 2. *ph.*, pharynx; *s. g.*, salivary gland.

Fig. 16. Pharynx and salivary gland, ventral aspect, × 2, of the same specimen.

Fig. 17. Genitalia, × 2, of the same specimen.



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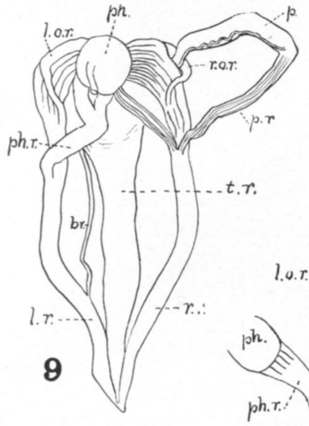

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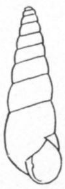

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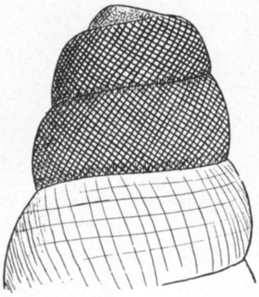

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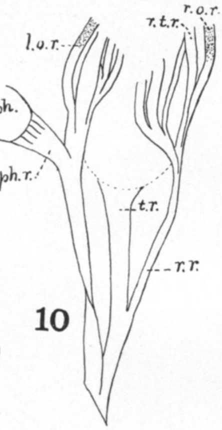

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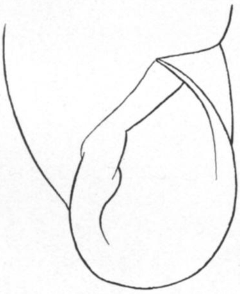

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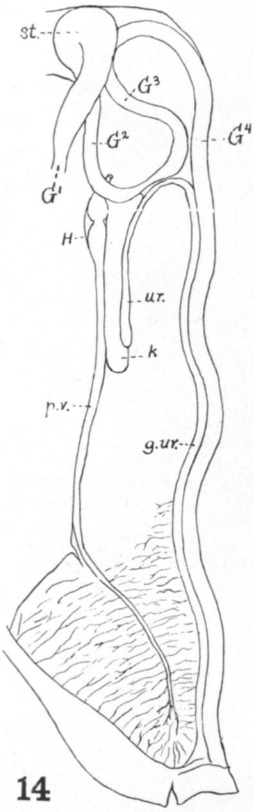

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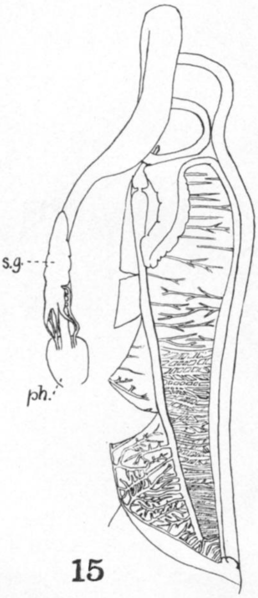

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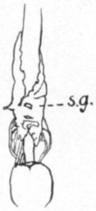

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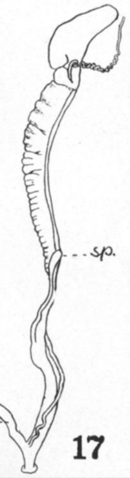

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